



**US Army Corps  
of Engineers**  
Waterways Experiment  
Station

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## **Preliminary Data Summary for February 1995 CERC Field Research Facility**

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Coastal Engineering Research Center

**WES**

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# **February 1995**

## **Preliminary Data Summary**

by      Field Research Facility

U.S. Army Corps of Engineers  
Waterways Experiment Station  
Coastal Engineering Research Center  
1261 Duck Road  
Duck, NC 27949-4472

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## Preface

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This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

# 1 Introduction

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The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.75 m above the National Geodetic Vertical Datum (NGVD) of the year 1929.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local bathymetric, oceanographic, and meteorological conditions. This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Clifford F. Baron at (919) 261-3511.

Chapter 2 presents the meteorological data; Chapters 3 through 6 present oceanographic data; Chapter 7 presents nearshore profiles and bathymetry; and Chapter 8, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used and their operational status during the month. Figure 2 shows weather and ocean conditions for the month. Table 2 and Figure 3 identifies the location of the instruments. The water depths at the wave gauges and current meters vary and may be determined from information contained in Figure 9. Other installation information is contained in Table 1.

Times given in the report are referenced to eastern standard time (EST).

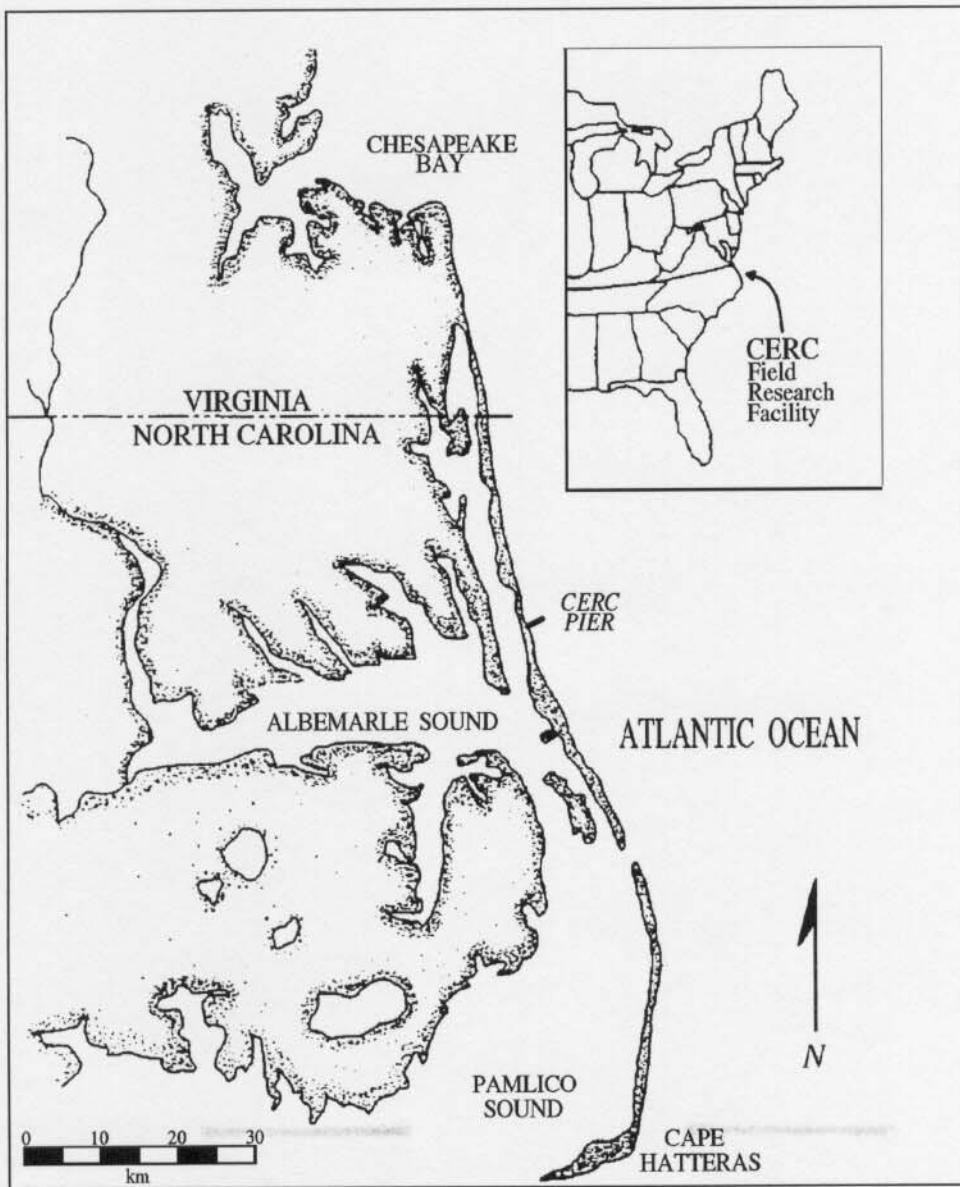


Figure 1. FRF Location Map

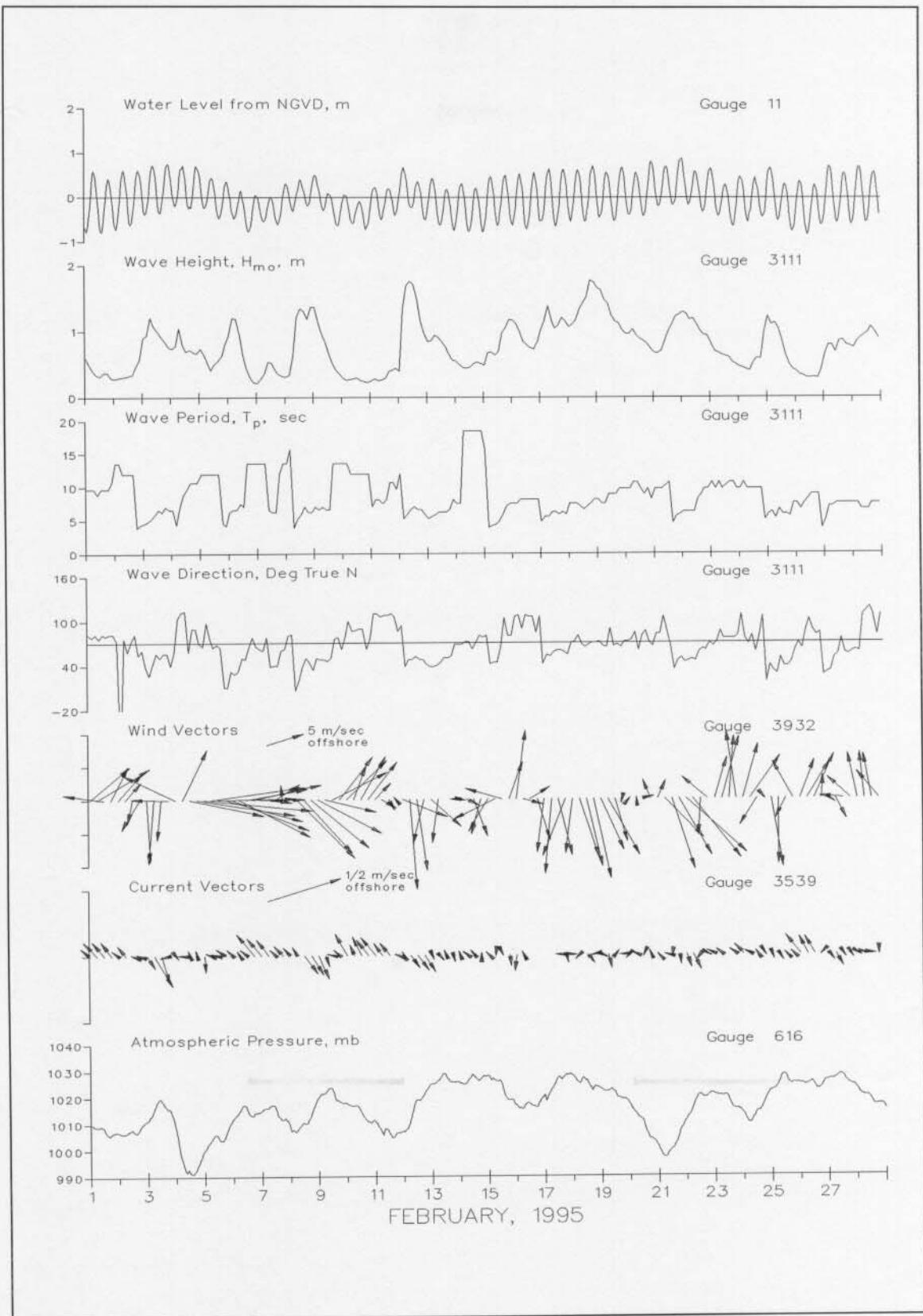


Figure 2. Month at a Glance

**Table 1**  
**Instrument Status/Data Availability**

			February 1995																												
Gauge ID	Description/Remarks	Gauge Status Data Collected	Day of the month																												
			1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	
616	Atmospheric Pressure	Gauge Status Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
604	Precipitation	Gauge Status Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
624	Air Temperature	Gauge Status Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3932	Anemometer	Gauge Status Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
641	Pressure Gauge on FRF pier	Gauge Status Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
625	Baylor staff on FRF pier	Gauge Status Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3111	8 Meter Array 309 m north of FRF	Gauge Status Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
111	Pressure Gauge center of 8 Meter Array	Gauge Status Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
630	Waverider buoy 4.0 km offshore	Gauge Status Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3539	Current meter 343 m north of FRF pier (1.6 km offshore)	Gauge Status Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11	NOAA tide gauge at end of pier	Gauge Status Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Visual Observations (daily oceanographic and meteorological observations)			Daily observation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Gauge Status \* = Operational / = Partial - = Non-Operational  
 Data Collected \* = All / = Partial - = None  
 Visual Observations \* = Complete / = Partial - = None

**Table 2**  
**Gauge Locations**

Gauge ID	Description	Latitude Degrees N	Longitude Degrees W	FRF Coordinates Crossshore m	Longshore m	Gauge Depth NGVD, m	Water Depth NGVD, m
616	Atmospheric Pressure	36 10' 57.03"	75 45' 5.50"	11.60	569.00	-----	-----
3932	Anemometer	36 11' 1.23"	75 44' 43.07"	585.20	517.30	19.50	-----
641	Pressure Gauge	36 10' 57.71"	75 44' 56.23"	239.11	516.64	-1.64	-1.96
625	Baylor Staff	36 11' 1.04"	75 44' 43.72"	568.00	516.64	Surface	-8.36
3111	8 Meter Array North	36 11' 19.14"	75 44' 36.41"	915.23	990.16	-7.50	-7.90
	8 Meter Array South	36 11' 11.28"	75 44' 33.28"	914.20	735.37	-7.42	-7.90
	8 Meter Array East	36 11' 13.70"	75 44' 32.56"	954.51	800.58	-7.62	-8.13
	8 Meter Array West	36 11' 12.48"	75 44' 37.11"	834.66	800.37	-6.98	-7.44
111	Pressure Gauge in center of 8 M Array	36 11' 14.06"	75 44' 34.39"	914.43	825.52	-7.76	-8.08
630	Waverider Buoy	36 10' 5.10"	75 41' 59.30"	3934.96	-2400.81	Surface	-17.00
3539	Current Meter	36 11' 23.57"	75 44' 9.12"	1605.80	907.60	-11.60	-11.70
11	NOAA Tide Gauge	36 11' 1.25"	75 44' 42.60"	596.49	514.20	Surface	-7.62

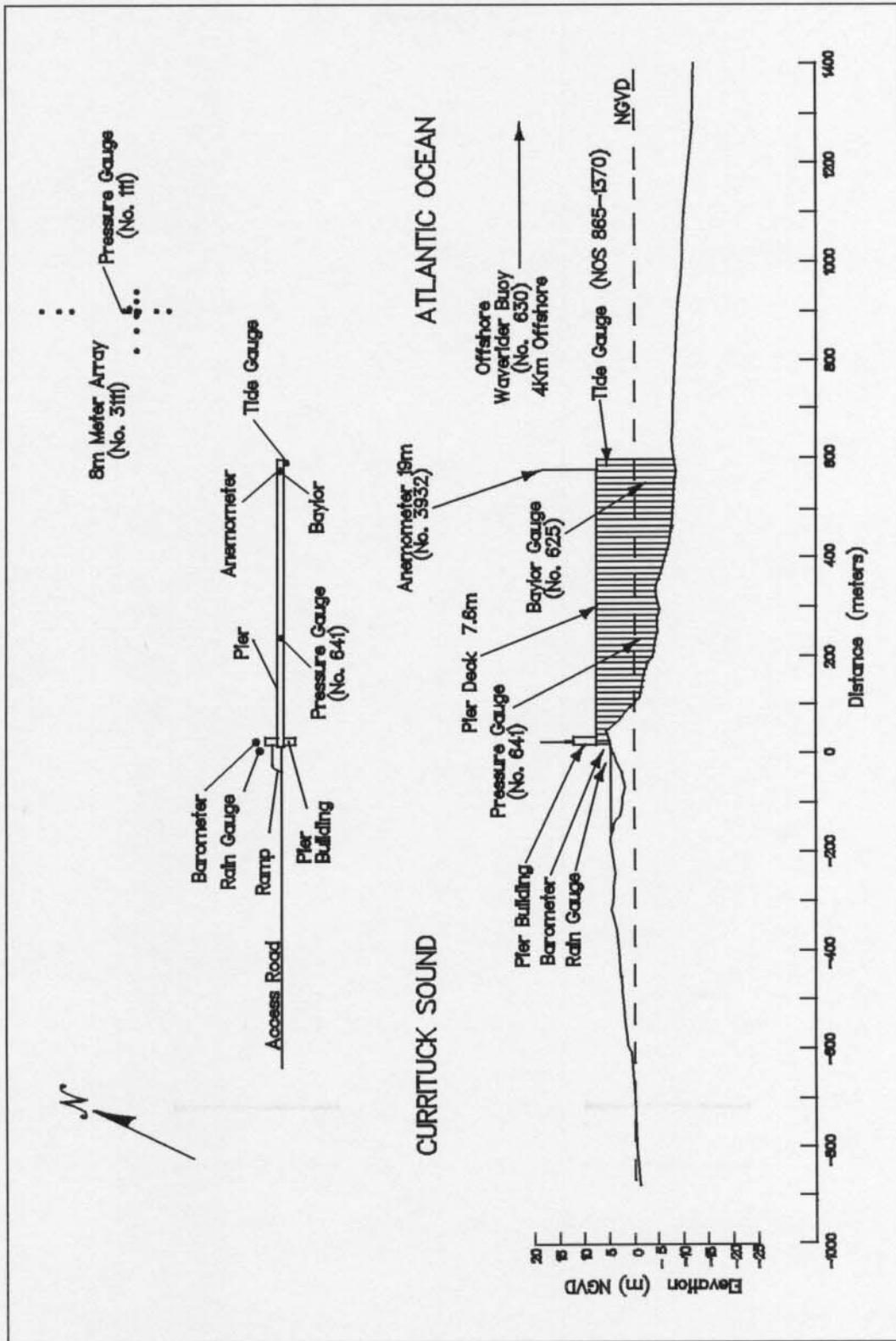


Figure 3. Instrument Locations, Elevations From NGVD

## 2 Meteorological Data

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A variety of instruments have been installed at the FRF (Figure 3) to monitor the meteorological conditions. The data presented in Table 3 are collected and stored using a Digital Equipment Corporation VAXstation 4000. For each instrument identified in Table 1, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m using a WeatherMeasure Skyvane anemometer. Monthly resultant wind speeds and directions (Figure 4) are determined by vector averaging the data. Wind directions (Table 3) indicate where the wind is coming from. Temperature and atmospheric pressure means (Table 3) are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 3 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -  
 $mm \times .03937 = in.$
2. Millibars (mb) to inches of mercury (in. Hg) -  
 $mb \times 0.02953 = in. Hg$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -  
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -  
 $m/s \times 1.943 = kn$

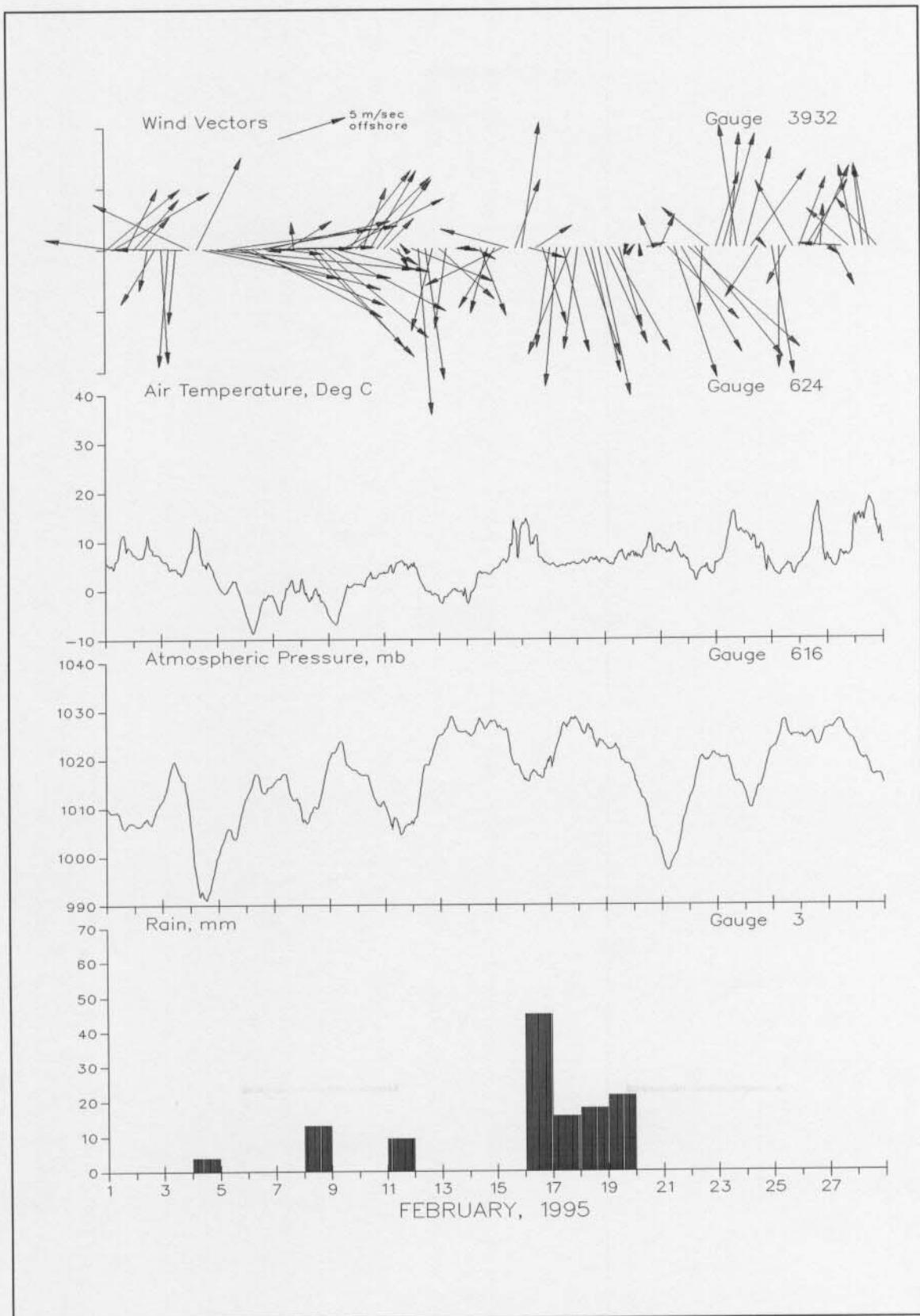


Figure 4. Meteorological Monthly Summary

**Table 3**  
**Meteorological Data**

Feb 1995						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	7	226	5.7	1010.0	0
	700	8	235	4.4	1009.1	0
	1300	5	99	10.1	1007.0	0
	1900	5	203	9.0	1006.7	0
2	100	5	217	7.5	1006.5	0
	700	3	217	6.8	1006.8	0
	1300	3	9	10.5	1007.0	0
	1900	5	27	7.5	1009.7	0
3	100	9	357	6.3	1011.8	0
	700	10	4	4.2	1017.3	0
	1300	6	4	4.4	1018.2	0
	1900	5	91	3.9	1015.5	0
4	100	8	119	8.1	1005.3	0
	700	8	203	11.8	993.3	3
	1300	10	284	5.4	991.4	0
	1900	13	280	4.7	995.4	0
5	100	14	276	1.1	1001.0	0
	700	12	261	-0.5	1005.1	0
	1300	10	269	1.8	1003.8	0
	1900	11	288	-0.3	1007.8	0
6	100	11	295	-5.0	1012.4	0
	700	11	301	-8.8	1016.4	0
	1300	8	258	-3.5	1014.0	0
	1900	9	255	-1.2	1014.3	0
7	100	6	269	-1.8	1015.5	0
	700	3	277	-4.5	1016.8	0
	1300	4	234	0.6	1014.1	0
	1900	2	175	-0.3	1011.9	0
8	100	2	87	2.5	1007.2	0
	700	12	319	-2.1	1008.3	13
	1300	10	322	0.5	1010.0	0
	1900	10	314	-2.3	1015.3	0
9	100	10	301	-5.6	1020.7	0
	700	7	285	-6.8	1022.6	0
	1300	8	240	-1.7	1021.3	0
	1900	8	214	0.7	1018.1	0
10	100	8	221	1.2	1017.2	0
	700	5	198	0.7	1016.9	0
	1300	7	207	3.0	1013.3	0
	1900	7	214	3.2	1010.6	0

**Table 3**  
**Meteorological Data (continued)**

Day	Hour	Feb 1995				
		Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
11	100	3	220	3.5	1010.2	0
	700	2	305	3.9	1006.8	9
	1300	2	334	5.7	1005.3	0
	1900	1	143	5.4	1006.5	0
12	100	6	294	5.0	1007.3	0
	700	14	356	2.1	1013.9	0
	1300	11	353	-0.1	1018.9	0
	1900	7	12	-0.8	1022.7	0
13	100	6	317	-2.4	1025.0	0
	700	7	7	-1.4	1027.1	0
	1300	4	347	0.3	1027.0	0
	1900	0		-0.2	1025.7	0
14	100	1	282	-2.8	1025.3	0
	700	2	299	0.6	1026.6	0
	1300	6	342	3.3	1027.3	0
	1900	5	13	3.2	1027.5	0
15	100	5	27	4.3	1027.4	0
	700	6	60	6.2	1026.0	0
	1300	5	108	8.5	1021.8	0
	1900	6	197	11.4	1018.9	0
16	100	10	187	13.4	1015.9	0
	700	3	287	9.2	1017.0	44
	1300	3	233	11.0	1016.6	0
	1900	6	345	5.6	1018.1	0
17	100	8	6	5.2	1018.4	0
	700	11	4	4.8	1024.0	15
	1300	9	348	4.9	1027.0	0
	1900	9	19	5.5	1028.2	0
18	100	8	6	5.4	1027.3	0
	700	9	344	5.3	1026.3	18
	1300	10	348	6.4	1025.0	0
	1900	12	349	5.5	1023.9	0
19	100	8	339	5.9	1022.5	0
	700	9	334	5.1	1022.4	21
	1300	7	346	7.8	1020.2	0
	1900	1	10	6.5	1019.1	0
20	100	0		7.3	1016.3	0
	700	0		6.4	1012.1	0
	1300	1	255	10.1	1007.9	0
	1900	3	159	7.7	1003.8	0

**Table 3**  
**Meteorological Data (concluded)**

Feb 1995						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	3	200	8.2	999.8	0
	700	8	319	8.0	997.6	0
	1300	11	344	9.3	1000.6	0
	1900	10	333	6.4	1007.8	0
22	100	11	316	4.4	1012.5	0
	700	11	325	1.7	1017.9	0
	1300	6	2	4.4	1019.9	0
	1900	5	134	3.7	1020.7	0
23	100	6	194	5.5	1020.8	0
	700	10	193	7.4	1020.3	0
	1300	9	184	15.0	1017.2	0
	1900	10	173	11.7	1015.5	0
24	100	8	193	11.5	1012.9	0
	700	7	211	10.2	1010.7	0
	1300	5	29	8.1	1014.4	0
	1900	0		4.6	1019.3	0
25	100	10	351	4.4	1022.5	0
	700	10	1	2.9	1026.0	0
	1300	3	23	4.7	1026.2	0
	1900	6	154	3.0	1025.0	0
26	100	6	198	5.4	1024.9	0
	700	6	208	7.2	1024.9	0
	1300	7	201	15.7	1023.4	0
	1900	3	183	12.3	1024.6	0
27	100	1	309	6.2	1026.5	0
	700	3	336	4.7	1027.4	0
	1300	3	94	7.1	1027.2	0
	1900	4	136	7.2	1024.4	0
28	100	7	170	14.0	1022.1	0
	700	7	175	13.9	1020.0	0
	1300	7	171	18.4	1017.4	0
	1900	5	144	12.1	1016.8	0
Resultant			Mean	Mean	Total	
	2	299	4.8	1016.1	123	

## 3 Wave Data

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Wave data are collected from three different sets of instruments, as shown in Table 1 and Figure 3. The first is an array of fifteen pressure gauges, collectively referred to as gauge 3111 (gauge 111 being one of them).

Directional information is computed from these gauges using a iterative maximum likelihood estimator. The second is a Baylor staff gauge (625) and a pressure gauge (641), both attached to the pier. The third is a Waverider buoy (630). The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAXstation 4000. Data is sampled at 2 hertz, with five contiguous 34 minute records, for a total collection period of nearly 2 hours and 51 minutes. This report reflects the data collection periods of 0100, 0700, 1300, and 1900 EST. The results are based only on the first 34 minute record. The exception is the 8 Meter Array (3111) which condenses the first four records into one statistical value.

Wave height  $H_{mo}$  is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gauge has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 degrees of freedom calculated from a 34-min record. Peak wave period  $T_p$  is defined as the period associated with the maximum energy in the spectrum.

Table 4 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 4 are average values computed from this data. Figure 5 is a time history of all  $H_{mo}$  and  $T_p$  values obtained for all gauges.

Differences in wave periods between wave gauges (Table 4 and Figure 5) may be the result of wave breaking, wave reformation, the presence of multiple wave trains containing nearly equal energy, and statistical variations in spectral estimations.

**Table 4**  
**Wave Data**

Feb 1995										
Day	Hour	641		625		3111			630	
		Pressure Gauge Hmo,m	Tp,sec	Baylor Gauge Hmo,m	Tp,sec	8 Meter Array Hmo,m	Tp,sec	Dir,TN	Waverider Hmo,m	Tp,sec
1	0100	0.22	10.3	0.56	10.3	0.59	9.8	82	0.70	10.3
	0700	0.20	9.9	0.32	9.5	0.39	9.8	82	0.42	10.3
	1300	0.13	16.0	0.30	14.3	0.32	9.8	82	0.35	8.9
	1900	0.24	9.2	0.32	9.9	0.37	9.8	82	0.40	9.9
2	0100	0.13	14.3	0.24	10.3	0.28	13.6	72	0.28	7.4
	0700	0.21	11.2	0.26	11.7	0.30	12.0	76	0.29	13.5
	1300	0.19	6.1	0.26	11.7	0.32	12.0	72	0.36	11.7
	1900	0.31	3.8	0.50	3.9	0.46	3.9	54	0.60	3.8
3	0100	0.45	4.4	0.79	4.3	0.90	4.6	38	0.89	4.4
	0700	0.67	5.1	1.07	5.2	1.20	5.3	42	1.31	5.1
	1300	0.57	6.5	0.91	6.5	1.00	6.6	50	1.37	6.5
	1900	0.42	6.1	0.77	6.0	0.85	7.1	56	0.95	6.3
4	0100	0.40	6.3	0.73	6.6	0.74	6.6	58	0.82	6.1
	0700	0.76	6.8	0.85	6.1	1.04	7.1	112	1.31	6.1
	1300	0.53	7.8	0.63	9.2	0.69	9.8	58	0.91	8.1
	1900	0.41	10.7	0.65	11.7	0.68	10.8	90	1.05	3.1
5	0100	0.42	12.2	0.68	12.9	0.73	12.0	66	1.01	3.1
	0700	0.30	11.2	0.46	11.2	0.51	12.0	76	0.79	12.2
	1300	0.30	11.2	0.41	11.7	0.50	12.0	68	0.62	11.7
	1900	0.33	5.1	0.56	4.2	0.63	4.6	10	0.75	12.2
6	0100	0.49	5.6	0.79	4.8	0.94	6.2	32	1.10	5.7
	0700	0.71	6.3	1.06	6.6	1.19	6.6	32	1.45	7.0
	1300	0.38	6.0	0.64	6.5	0.64	7.1	48	0.88	6.8
	1900	0.14	15.1	0.32	14.3	0.30	13.6	78	0.53	2.5
7	0100	0.11	15.1	0.19	14.3	0.21	13.6	62	0.31	12.9
	0700	0.18	4.5	0.35	15.1	0.35	13.6	78	0.38	5.0
	1300	0.28	6.3	0.49	6.3	0.52	6.2	40	0.66	6.5
	1900	0.18	4.9	0.34	5.1	0.35	12.0	60	0.45	5.7
8	0100	0.18	8.6	0.30	15.1	0.31	13.6	80	0.34	13.5
	0700	0.29	3.0	0.57	16.0	0.63	3.9	6	0.95	4.0
	1300	0.76	6.1	1.08	5.9	1.34	5.9	38	1.54	6.0
	1900	0.73	6.1	1.11	6.1	1.18	6.2	44	1.37	6.1
9	0100	0.85	6.8	1.19	7.0	1.37	7.1	50	1.65	6.6
	0700	0.59	6.3	0.86	6.8	0.97	7.1	48	1.17	7.0
	1300	0.38	6.1	0.61	13.5	0.66	6.6	50	0.83	6.6
	1900	0.23	12.9	0.40	14.3	0.41	13.6	78	0.50	11.2
10	0100	0.17	10.3	0.25	10.3	0.29	13.6	78	0.44	13.5
	0700	0.14	12.2	0.24	12.2	0.27	12.0	86	0.31	12.9
	1300	0.16	12.2	0.24	11.7	0.29	12.0	90	0.37	12.2
	1900	0.14	12.2	0.21	12.2	0.24	12.0	62	0.31	12.2

**Table 4**  
**Wave Data (continued)**

Feb 1995										
Day	Hour	641		625		3111			630	
		Pressure Gauge	Baylor Gauge	Hmo,m	Tp,sec	Hmo,m	Tp,sec	8 Meter Array	Dir,TN	Waverider
11	0100	0.19	7.2	0.20	7.4	0.25	7.1	110	0.32	7.0
	0700	0.19	7.8	0.22	8.3	0.25	8.2	106	0.31	7.2
	1300	0.22	8.1	0.24	8.1	0.29	8.2	108	0.30	11.2
	1900	0.36	10.7	0.37	10.7	0.41	10.8	106	0.47	11.2
12	0100	0.30	10.7	0.33	7.8	0.39	12.0	94	0.46	12.2
	0700	0.99	5.9	1.40	5.6	1.68	5.9	48	1.69	5.9
	1300	0.88	7.0	1.51	7.0	1.70	7.1	52	1.95	7.8
	1900	0.66	6.5	1.10	7.0	1.16	6.6	48	1.38	7.0
13	0100	0.47	5.6	0.78	5.5	0.85	5.3	38	1.07	5.7
	0700	0.49	5.4	0.80	5.5	0.94	5.9	40	1.07	6.1
	1300	0.43	6.0	0.78	6.1	0.84	6.2	50	1.05	6.3
	1900	0.37	5.6	0.60	6.5	0.65	6.6	52	0.87	5.9
14	0100	0.24	5.4	0.47	7.8	0.54	7.6	68	0.68	7.6
	0700	0.27	8.9	0.41	18.3	0.45	18.5	72	0.48	17.1
	1300	0.24	18.3	0.46	18.3	0.45	18.5	62	0.59	8.9
	1900	0.27	17.1	0.47	17.1	0.53	18.5	80	0.79	4.5
15	0100	0.22	17.1	0.48	17.1	0.48	15.7	80	0.63	4.1
	0700	0.38	8.6	0.67	4.2	0.68	4.2	44	0.88	4.0
	1300	0.29	4.4	0.62	4.5	0.69	4.8	64	0.81	4.6
	1900	0.81	6.5	0.91	6.6	1.05	7.1	80	1.22	6.6
16	0100	0.80	7.6	1.10	8.1	1.17	7.6	106	1.59	8.1
	0700	0.88	7.8	0.90	8.1	1.00	8.2	90	1.31	8.6
	1300	0.67	7.8	0.74	8.3	0.80	8.2	106	1.01	8.3
	1900	0.61	7.2	0.62	8.1	0.73	8.2	84	0.91	7.6
17	0100	0.58	4.8	0.94	4.7	1.00	4.8	42	1.19	4.8
	0700	0.80	5.5	1.20	5.6	1.38	5.6	52	1.75	5.6
	1300	0.49	5.5	1.04	6.8	1.05	6.2	60	1.29	6.3
	1900	0.59	5.2	1.11	5.7	1.21	6.2	58	1.40	5.6
18	0100	0.51	5.6	0.95	6.6	1.07	7.6	70	1.28	7.0
	0700	0.63	7.8	0.97	7.4	1.17	7.6	80	1.35	7.4
	1300	0.65	5.5	1.24	5.7	1.43	6.6	64	1.62	7.2
	1900	0.96	7.8	1.50	7.6	1.77	7.6	70	2.04	7.6
19	0100	0.98	8.9	1.46	7.8	1.66	8.2	72	1.69	7.6
	0700	0.74	7.8	1.35	7.8	1.48	7.6	64	1.63	8.3
	1300	0.61	8.9	1.13	8.9	1.24	8.9	66	1.49	8.1
	1900	0.53	8.6	1.04	7.8	1.12	9.8	64	1.32	7.6
20	0100	0.51	9.5	0.88	9.2	0.96	9.8	72	1.10	9.9
	0700	0.49	10.7	0.91	9.9	1.03	10.8	84	1.12	9.9
	1300	0.47	10.3	0.82	9.9	0.88	9.8	80	0.97	9.5
	1900	0.42	9.5	0.71	9.2	0.81	9.8	70	0.86	9.5

**Table 4**  
**Wave Data (concluded)**

Feb 1995										
Day	Hour	641		625		3111			630	
		Pressure Gauge	Hmo,m Tp,sec	Baylor Gauge	Hmo,m Tp,sec	8 Meter Array	Hmo,m Tp,sec Dir,TN	Waverider	Hmo,m Tp,sec	
21	0100	0.39	9.9	0.61	8.3	0.68	9.8	82	0.73	9.5
	0700	0.33	9.9	0.57	9.9	0.70	9.8	106	0.75	9.2
	1300	0.46	10.7	0.78	10.3	1.00	10.8	66	1.01	9.9
	1900	0.59	5.3	1.08	5.3	1.22	5.6	46	1.52	5.6
22	0100	0.66	6.0	1.14	6.3	1.29	6.2	44	1.51	6.0
	0700	0.55	5.9	1.01	6.5	1.18	6.2	48	1.41	7.0
	1300	0.55	6.0	0.99	8.1	1.10	8.2	58	1.33	7.8
	1900	0.40	10.7	0.89	9.5	0.95	9.8	60	1.13	9.5
23	0100	0.39	10.7	0.74	10.7	0.81	10.8	66	0.98	10.3
	0700	0.32	9.9	0.61	10.3	0.68	10.8	86	0.80	9.9
	1300	0.35	10.3	0.50	10.3	0.64	9.7	0	0.73	9.9
	1900	0.34	9.5	0.54	9.9	0.52	10.8	76	0.79	10.3
24	0100	0.34	9.2	0.44	9.9	0.46	9.8	108	0.63	9.9
	0700	0.30	9.2	0.39	9.2	0.41	9.8	68	0.59	9.9
	1300	0.35	8.1	0.52	10.3	0.53	9.8	58	0.63	9.9
	1900	0.34	7.6	0.54	4.2	0.58	9.8	106	0.73	4.6
25	0100	0.73	5.7	1.16	5.6	1.23	5.9	40	1.60	5.6
	0700	0.60	5.7	1.03	5.9	1.13	5.3	28	1.33	5.4
	1300	0.49	6.3	0.88	6.3	0.86	5.9	38	1.21	6.0
	1900	0.27	8.9	0.52	4.9	0.49	5.6	44	0.72	5.6
26	0100	0.22	8.6	0.36	6.6	0.39	7.6	70	0.50	7.2
	0700	0.22	8.6	0.30	8.6	0.32	7.6	86	0.37	6.6
	1300	0.16	8.1	0.26	8.1	0.29	8.9	88	0.32	8.3
	1900	0.21	8.9	0.29	8.9	0.28	8.9	84	0.40	8.9
27	0100	0.33	5.2	0.58	4.1	0.65	5.0	30	0.77	4.5
	0700	0.45	6.8	0.74	7.2	0.80	7.1	50	0.93	7.0
	1300	0.37	7.4	0.73	7.4	0.85	7.6	76	1.02	7.2
	1900	0.47	6.3	0.74	7.6	0.80	7.6	54	0.93	7.4
28	0100	0.35	7.6	0.67	7.8	0.75	7.6	60	0.88	7.8
	0700	0.68	6.8	0.82	6.5	0.90	6.6	108	1.13	6.1
	1300	0.81	7.4	0.79	7.4	0.98	6.6	118	1.23	7.0
	1900	0.98	7.4	0.88	7.8	0.99	7.6	80	1.26	7.6
Mean		0.44	8.2	0.70	8.6	0.77	8.7	66	0.93	7.8
Std dev		0.22	3.0	0.33	3.2	0.37	3.0	23	0.43	2.7

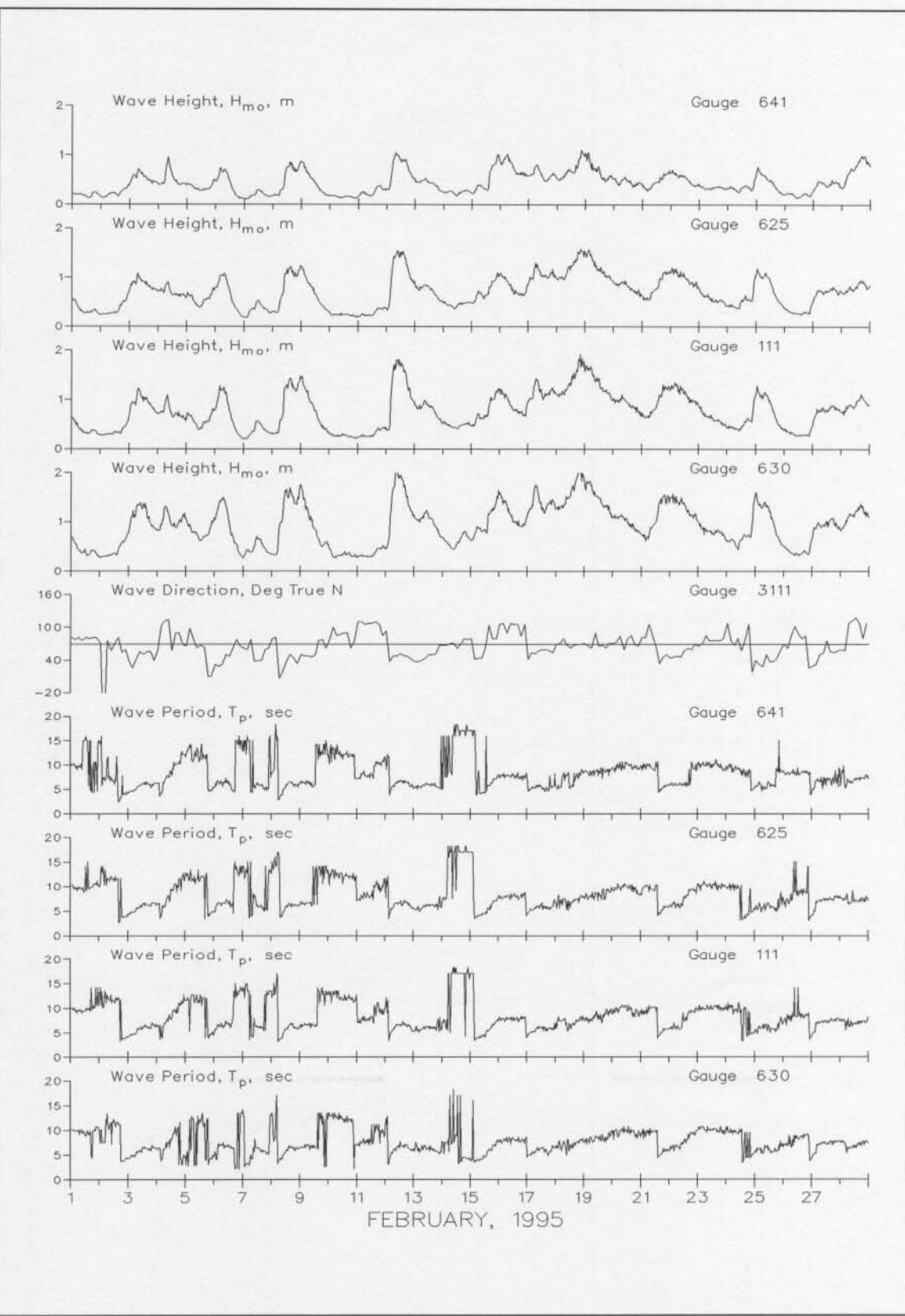


Figure 5. Wave Heights and Periods

## 4 Current Data

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Current data (Table 5) are collected from a Marsh-McBirney electromagnetic biaxial current meter and by visually observing the movement of small drogues on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier, approximately 12 m offshore (Table 6).

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or off-shore (eastward). All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the cross-shore and longshore data. Current directions indicate the direction that the current is moving towards. Current data are plotted in Figure 2.

**Table 5**  
**Current Meter Data - Gauge 3539**

FEBRUARY 1995

Cross Long								Cross Long								Cross Long							
Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir						
1	100	4	-6	8	312		1300	1	-14	15	337	20	100	4	2	4	218						
	700	5	-12	14	320		1900	3	-12	14	326		700	3	-2	4	295						
	1300	4	-12	13	323	11	100	5	-15	17	324		1300	1	1	2	203						
	1900	3	-12	13	327		700	3	-9	11	326		1900	0	-2	3	339						
2	100	3	-4	6	312		1300	3	-10	11	324	21	100	0	0	0							
	700	3	-8	10	324		1900	1	0	1	290		700	1	0	1	287						
	1300	1	0	2	292	12	100	0	-1	3	332		1300	1	2	3	188						
	1900	2	-1	3	287		700	-1	11	11	149		1900	2	8	8	172						
3	100	0	11	11	152		1300	-2	14	14	149	22	100	1	11	11	163						
	700	-2	26	26	153		1900	-1	14	15	152		700	0	13	13	159						
	1300	2	21	21	166	13	100	0	4	4	160		1300	5	4	6	213						
	1900	6	0	6	253		700	-1	5	5	143		1900	-1	2	3	121						
4	100	0	3	3	147		1300	0	-3	4	340	23	100	4	-3	6	297						
	700	3	0	3	272		1900	0	5	5	165		700	2	-4	5	313						
	1300	0	-3	4	339	14	100	0	-2	3	342		1300	inoperative									
	1900	0	-3	4	345		700	2	-2	4	310		1900	3	-4	6	307						
5	100	4	12	13	176		1300	1	-3	4	323	24	100	3	-8	9	320						
	700	3	-2	4	294		1900	0	0	0			700	3	-3	5	298						
	1300	4	-2	5	283	15	100	1	-1	3	319		1300	1	-2	3	328						
	1900	4	-6	8	308		700	0	1	1	187		1900	0	2	2	151						
6	100	2	-5	6	318		1300	0	1	1	157	25	100	0	4	4	162						
	700	1	-3	4	329		1900	2	9	9	173		700	0	6	6	153						
	1300	3	-5	6	311	16	100	6	11	13	186		1300	1	-1	2	320						
	1900	5	-18	20	324		700	0	-2	3	335		1900	1	-1	3	317						
7	100	5	-14	16	323		1300					26	100	4	-15	17	325						
	700	3	-13	14	326		1900						700	1	-13	14	336						
	1300	2	-4	6	316	17	100						1300	2	-13	14	332						
	1900	3	-8	9	321		700						1900	1	1	1	219						
8	100	2	-6	7	322		1300	2	0	3	272	27	100	-1	6	6	147						
	700	1	-6	7	333		1900	1	7	7	167		700	0	11	11	155						
	1300	-2	16	16	148	18	100	-1	1	3	92		1300	0	3	4	149						
	1900	-1	17	17	152		700	4	2	5	222		1900	0	4	4	150						
9	100	0	19	19	160		1300	-1	8	8	144	28	100	-1	3	3	127						
	700	1	8	9	165		1900	2	0	2	255		700	-2	2	3	100						
	1300	3	-1	4	285	19	100	-3	4	5	118		1300	-2	1	3	94						
	1900	2	-4	6	316		700	2	11	11	169		1900	0	1	1	178						
10	100	2	-17	18	334		1300	-2	-1	4	34												
	700	0	-7	8	340		1900	2	0	2	267												

**KEY:**

- +cross-shore = offshore, cm/sec
- cross-shore = onshore, cm/sec
- +longshore = south, cm/sec
- longshore = north, cm/sec
- Speed = Resultant speed, cm/sec
- Dir = Resultant direction, degrees true north

**Table 6**  
**Visually Observed Current Data**

Day	Feb 1995											
	Pier End				Mid-Surf Zone				Beach			
	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir	
1	-30	19	36	218	10	-9	14	30	no observation			
2	9	-10	14	22	0	0	0	0	South	0		
3	0	47	47	160	0	51	51	160	North	43	S	
4	9	10	14	118	27	27	37	70	North	27	N	
5	20	16	25	109	10	5	11	95	North	9	S	
6	12	41	42	143	-20	68	71	177	North	61	S	
7	4	12	12	141	3	8	8	138	North	4	S	
8	0	41	41	160	0	38	38	160	North	55	S	
9	9	30	32	143	12	41	42	143	North	30	S	
10	11	-36	37	357	2	-8	8	357	South	12	N	
11	0	-8	8	340	1	4	4	143	South	8	S	
12	0	68	68	160	0	102	102	160	no observation			
13	0	32	32	160	0	41	41	160	North	40	S	
14	0	17	17	160	0	5	5	160	North	9	S	
15	0	23	23	160	0	17	17	160	North	13	S	
16	20	-7	21	52	24	-41	47	11	South	29	N	
17	-15	51	53	177	0	87	87	160	no observation			
18	0	51	51	160	0	44	44	160	North	25	S	
19	0	61	61	160	11	55	57	149	no observation			
20	0	17	17	160	14	9	17	104	South	36	N	
21	0	55	55	160	0	32	32	160	North	27	S	
22	8	55	56	151	0	102	102	160	North	34	S	
23	22	-44	49	7	18	-61	64	357	South	8	N	
24	20	-23	30	22	7	-15	17	7	South	11	N	
25	-4	25	26	169	-12	47	48	174	North	28	S	
26	18	-24	30	17	12	-14	18	22	South	0		
27	0	30	30	160	0	15	15	160	North	23	S	
28	-1	6	6	171	6	-41	41	349	South	29	N	

**KEY:**

- +cross-shore = offshore, cm/sec
- cross-shore = onshore, cm/sec
- +longshore = south, cm/sec
- longshore = north, cm/sec
- Speed = Resultant speed, cm/sec
- Dir = Resultant direction, degrees true north

## 5 Visual Observations

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Visual wave direction measurements (Table 7) of both the primary wave train (i.e. that having the higher wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and depth of visibility are also taken daily at the seaward end of the pier. A Bucket Thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The temperature is then read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the depth of visibility.

**Table 7**  
**Visual Observations**

Feb 1995								
Day	Time	Wave Approach Angle at Pier End deg from True N		Radar Wave Angle deg from True N	Width of Surf Zone, m	Water Characteristics at Pier End		
		Primary	Secondary			Temp., C	Density g/cc	Secchi Vis., m
1	0800	none	visible		2	7.2	1.0255	
2	0840	140			10	7.8	1.0260	1.8
3	0716	30	55		116	7.8	1.0257	0.9
4	0940	105			14	6.9	1.0244	1.5
5	0925	none	visible		7	5.0	1.0246	1.8
6	0738	40	20		110	5.0	1.0251	0.6
7	0715	20			3	5.3	1.0258	2.1
8	0830	10		20	8	6.7	1.0261	1.8
9	0715	50	20		107	5.6	1.0268	0.9
10	0715	120			2	5.6	1.0266	1.8
11	1030	95			4	5.8	1.0262	4.6
12	1030	40		45	205	5.8	1.0266	0.6
13	0745	45	20	45	117	5.0	1.0264	0.9
14	0835	60			2	4.4	1.0242	2.7
15	0730	55	35		9	4.7	1.0243	2.4
16	0730	105			16	5.8	1.0250	1.2
17	0730	50	30	55	120	5.0	1.0230	1.8
18	0940	65	25	60	132	5.0	1.0227	1.5
19	0915	70	40	65	132	5.3	1.0229	0.9
20	0745	40	90		11	5.3	1.0226	2.4
21	1020	30	65	65	11	5.6	1.0246	2.7
22	0730	55	30	45	135	5.6	1.0240	1.2
23	0730	70	150	80	113	5.6	1.0250	1.2
24	0730	135			6	6.4	1.0256	2.1
25	1000	45		50	137	5.8	1.0257	1.2
26	1216	none	visible		9	6.9	1.0257	2.1
27	0718	50	35		13	6.4	1.0257	2.1
28	0710	100	120	80	7	7.2	1.0252	4.6

## 6 Water Levels

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Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A NOS acoustic tide gauge (Next Generation Water Level Measurement System, NGWLMS) is used to collect water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 6 along with a list of means and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level. Table 8 contains the range, high, low, and mean water level for each 12.42-hr tidal cycle.

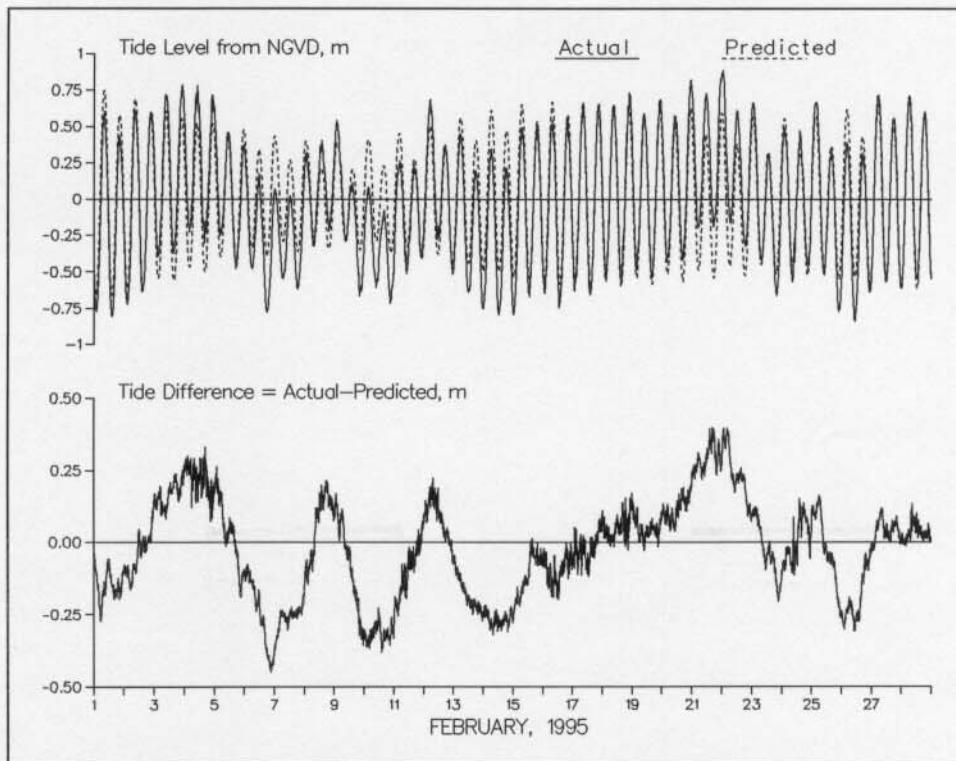


Figure 6. Water Level Variation

**Table 8**  
**Water Levels, m NGVD**

FEB 1995 Tide Levels															
High			Low			Mean	Range	High			Low			Mean	Range
Day	Time	m	Day	Time	m	m	m	Day	Time	m	Day	Time	m	m	
1	0824	0.60	1	0200	-0.78	-0.09	1.38	15	0718	0.49	15	0024	-0.80	-0.14	1.29
1	2030	0.43	1	1424	-0.81	-0.17	1.25	15	1930	0.51	15	1324	-0.67	-0.07	1.18
2	0842	0.61	2	0300	-0.73	-0.06	1.34	16	0754	0.54	16	0130	-0.65	-0.05	1.19
2	2136	0.60	2	1430	-0.64	0.00	1.23	16	1948	0.56	16	1318	-0.75	-0.09	1.32
3	0906	0.72	3	0254	-0.40	0.17	1.12	17	0824	0.67	17	0136	-0.63	0.01	1.30
3	2218	0.79	3	1554	-0.38	0.20	1.16	17	2036	0.65	17	1424	-0.66	0.01	1.32
4	1024	0.78	4	0412	-0.23	0.26	1.01	18	0912	0.65	18	0248	-0.55	0.07	1.20
4	2218	0.72	4	1612	-0.31	0.21	1.03	18	2136	0.73	18	1448	-0.56	0.09	1.29
5	1048	0.46	5	0436	-0.26	0.09	0.72	19	0930	0.59	19	0324	-0.49	0.06	1.08
5	2354	0.38	5	1724	-0.48	-0.06	0.86	19	2254	0.69	19	1548	-0.54	0.08	1.22
6	1154	0.17	6	0548	-0.48	-0.19	0.65	20	1042	0.57	20	0418	-0.44	0.08	1.01
7	0042	0.07	6	1806	-0.78	-0.34	0.85	20	2312	0.82	20	1654	-0.42	0.19	1.24
7	1242	0.02	7	0712	-0.55	-0.27	0.57	21	1148	0.73	21	0506	-0.20	0.25	0.93
8	0200	0.32	7	1818	-0.62	-0.16	0.94	22	0100	0.88	21	1736	-0.19	0.35	1.07
8	1406	0.40	8	0724	-0.33	0.05	0.73	22	1218	0.61	22	0712	-0.17	0.22	0.78
9	0142	0.54	8	1948	-0.22	0.15	0.77	23	0118	0.67	22	1900	-0.32	0.17	0.99
9	1436	0.11	9	0854	-0.30	-0.08	0.41	23	1324	0.31	23	0812	-0.43	-0.07	0.74
10	0324	0.08	9	2012	-0.67	-0.27	0.75	24	0224	0.49	23	1954	-0.66	-0.07	1.15
10	1612	-0.08	10	0942	-0.61	-0.34	0.53	24	1448	0.47	24	0848	-0.57	-0.06	1.04
11	0448	0.26	10	2100	-0.72	-0.21	0.99	25	0406	0.67	24	2118	-0.49	0.11	1.16
11	1542	0.23	11	1012	-0.52	-0.11	0.75	25	1612	0.32	25	1000	-0.52	-0.08	0.85
12	0530	0.69	11	2230	-0.41	0.14	1.10	26	0430	0.39	25	2212	-0.78	-0.20	1.16
12	1718	0.37	12	1042	-0.28	0.06	0.65	26	1706	0.32	26	1054	-0.85	-0.25	1.17
13	0530	0.45	12	2324	-0.52	-0.04	0.97	27	0542	0.71	26	2236	-0.64	0.03	1.36
13	1748	0.20	13	1212	-0.64	-0.23	0.84	27	1800	0.56	27	1154	-0.57	0.01	1.13
14	0630	0.34	13	2354	-0.76	-0.21	1.10	28	0618	0.71	28	0006	-0.61	0.06	1.32
14	1906	0.21	14	1254	-0.80	-0.29	1.01	28	1836	0.60	28	1324	-0.55	0.02	1.15

## 7 Bathymetry

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A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Geodimeter surveying system; a Geodimeter 140-T self-tracking, electronic theodolite, distance meter, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 7 shows the last survey in January 1995 and the survey(s) in February 1995 on profile line 188, located 517 m south of the pier.

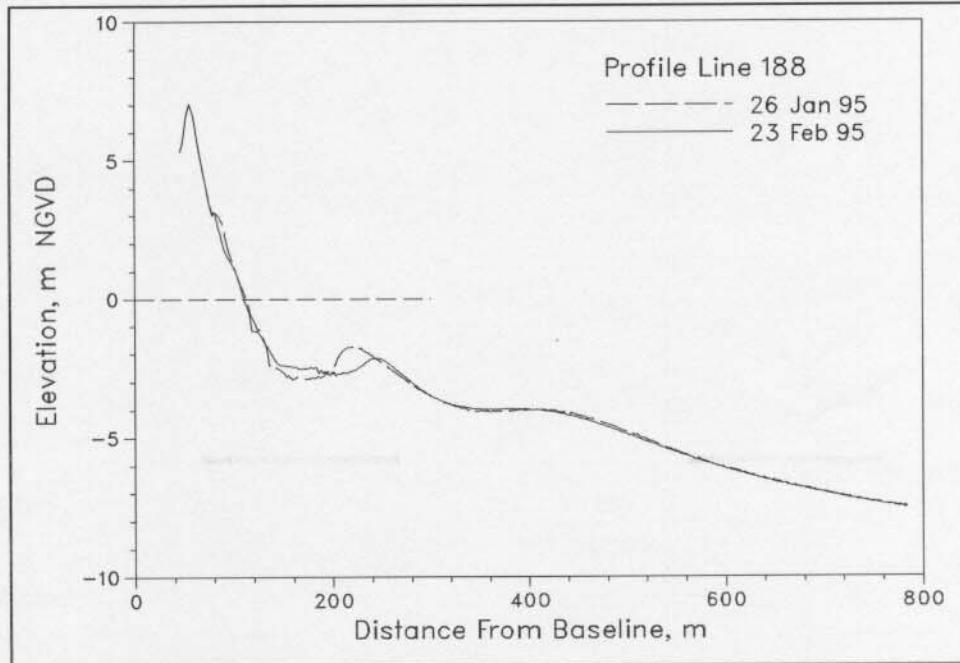


Figure 7. Monthly CRAB Profiles on Profile Line 188.

The profile envelope (Figure 8) reflects the maximum changes that occurred on the profile during 1995. Cross-hatched areas indicate changes to the annual envelope which occurred in December.

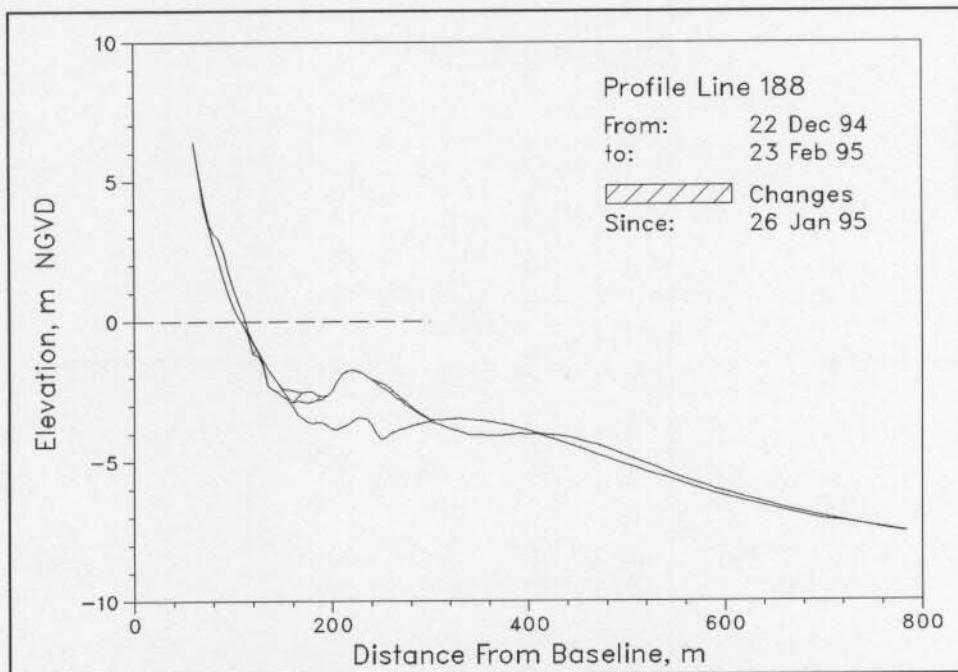


Figure 8. Profile Envelope - Profile Line 188.

B. Bathymetry. Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 25 January. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

There was no bathymetric survey in February. Figure 9 is included for reference only

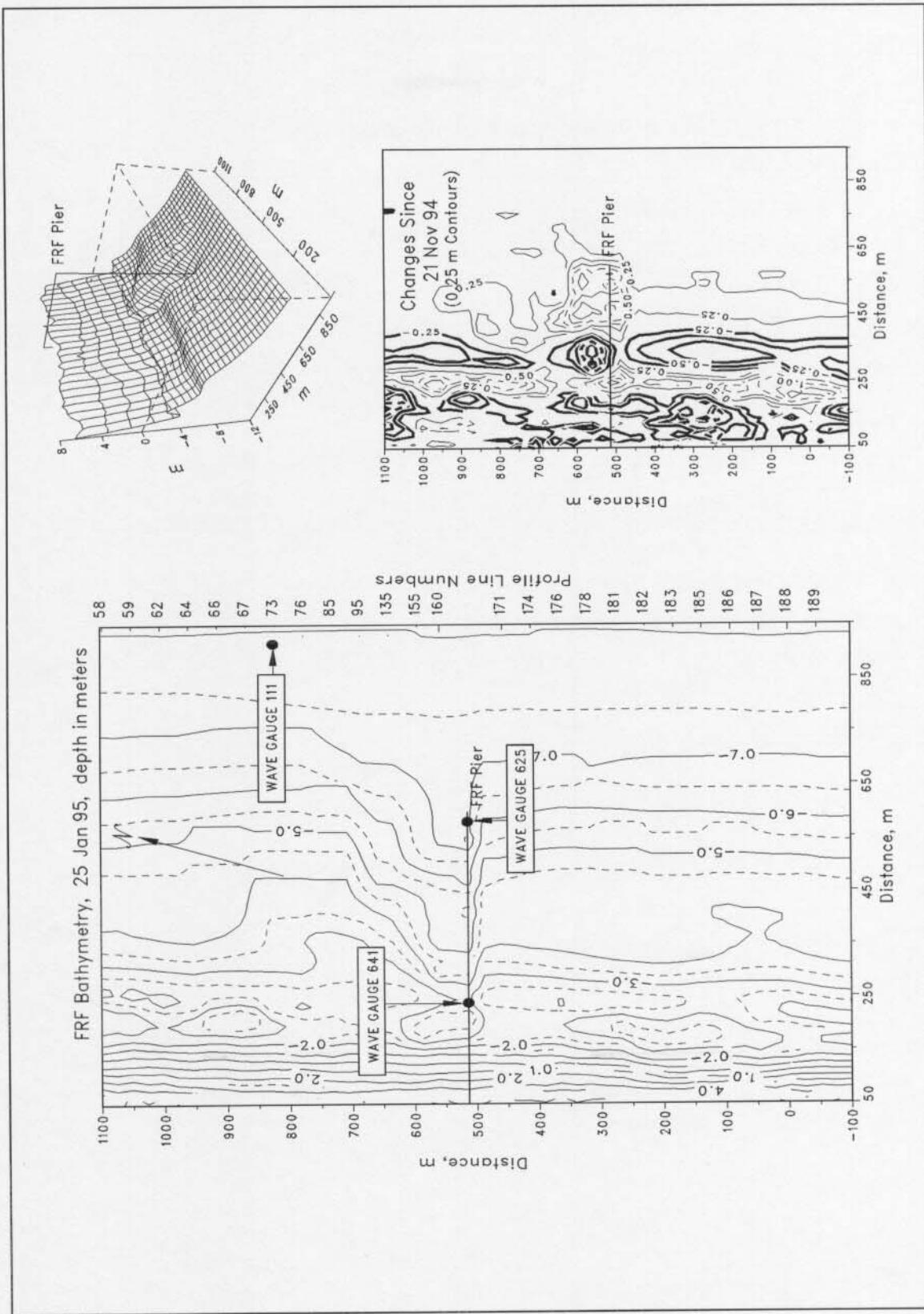


Figure 9. FRF Bathymetry, Depths Relative to NGVD

### Distribution List

#### Government Agencies:

Back Bay National Wildlife Refuge	U.S. Geological Survey
USACE-OCE	U.S. Library of Congress
USACE-SAD	U.S. National Park Service
USACE-NAP	U.S. National Weather Service
USACE-SAW	U.S. Naval Academy
USACE-WES	U.S. Naval Civil Eng. Lab
NAVSAC	U.S. Naval Oceanographic Off.
NOAA/NOS/OMS	U.S. Naval Research Lab
National Marine Fisheries	

#### Colleges/Universities:

Bucknell University	Scripps Institution of Oceanography
California Inst. of Tech.	Stockton State College
Duke Marine Lab	University Calif-Berkeley
East Carolina University	University of Florida
Florida Inst. of Tech.	University of Maryland-College Park
M.I.T.	University of Maryland-Baltimore
Naval Post Graduate School	University of North Carolina
NC State University	University of N C-Seagrant Program
Old Dominion University	University of Virginia
Oregon State University	Va. Inst. of Marine Science
Prince George's College	Rutgers University

#### Others:

Allied Signal Aerospace Co.	WCTI-TV
Applied Physics Lab	MEC Systems Corporation
Cape Hatteras Nat. Seashore	Moffatt & Nichol, Eng.
Coastal and Est. Res., Inc.	N.C. Div. Coastal Management
Coastal Science & Eng., Inc.	Oregon Inlet & Waterways Commis.
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#### Foreign:

Christchurch, Barbados
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Ministry of Construction, Coastal Division (Japan)
Norwegian Hydrodynamic Laboratories (Norway)
University of Sydney (Australia)